

Claims

1. An apparatus for producing simultaneously a plurality of spatially separated images from an object field comprising:

an optical system arranged to produce an image associated with a first focus condition;

a diffraction grating arranged to produce, in concert with the optical system, images associated with each diffraction order and

means for detecting the images,

wherein the optical system, diffraction grating and detecting means are located on an optical axis and the diffraction grating is located in a suitable grating plane and is distorted substantially according to a quadratic function so as to cause the images to be formed under various focus conditions.

2. The apparatus of claim 1 where the function according to which the grating is distorted includes further terms for producing different amounts of spherical aberration in the images associated with each diffraction order.

3. The apparatus of claim 2 where the spherical aberration of images associated with each diffraction order is arranged to correct for spherical aberration associated with the different depths of substantially parallel planes in object or image space.

4. An apparatus according to claim 1, ~~2 or 3~~ whereby the origin of the distortion function of the diffraction grating is displaced from the optical axis.

5. An apparatus according to claim 4, whereby the origin of the quadratic distortion function is displaced to cause alignment along the optical axis of the images associated with each diffraction order.

6. An apparatus according to claim 1 whereby the diffraction grating comprises a set of two or more diffraction gratings designed such that the various diffraction orders are spatially separated.

7. An apparatus according to claim 1 whereby the diffraction grating is any one of an amplitude-only diffraction grating, a phase only diffraction grating or a phase and amplitude diffraction grating.

8. An apparatus according to claim 1 whereby the diffraction grating is polarisation sensitive.

9. An apparatus according to claims 1 whereby the diffraction grating comprises two gratings sensitive to different polarisations and arranged such that the diffraction orders produced by said gratings are spatially separated.

10. An apparatus according to claim 1 whereby the diffraction grating is a programmable grating.

11. An apparatus according to claim 1 whereby the diffraction grating is a reflective grating or a transmissive grating.

12. An apparatus according to claim 1 whereby the grating is any of a two-level (binary) structure, a multi-level (digitised) structure or a continuous-level (analogue) structure.

13. The apparatus of claim 1 adapted for forming images on a plurality of image planes, from a single object plane.

14. The apparatus of claim 13 where the object plane contains a source of illumination which is used to illuminate the image planes.

15. The apparatus of claim 1 adapted for producing substantially in focus images in a common image plane, from a plurality of object planes.

¹⁸ 16. The apparatus of claim ¹⁷ ~~15~~ and further including apparatus according to claim ~~14~~ wherein the object planes ~~of claim 15~~ are coincident with the image planes ~~of claim 15~~.

¹⁹ 17. The apparatus of claims ¹⁷ ~~15~~ or ~~16~~ where each object plane contains an array of elements, capable of existing in at least two states and in which the detector means is capable of distinguishing between said states.

²⁰ 18. The apparatus of claim ¹⁹ ~~17~~ adapted for reading data from a three dimensional optical storage medium wherein object planes are located within the medium and the detecting means is capable of producing a signal dependent on the state of the elements.

19. An apparatus according to claim 1 and further including a dispersive system for introducing an offset to an input beam of radiation, said offset being perpendicular to the optical axis and proportional to the wavelength of the input radiation, whilst leaving the beams at each wavelength following parallel paths.